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SUPPOSED PHYSICAL EFFECTS OF THE PNEUMATIC HAMMER ON WORKERS IN INDIANA LIMESTONE.

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The following report is based upon a visit to Bedford, Ind., made by the writer for the purpose of consulting with Dr. Leake in regard to the effect of the pneumatic hammer on the health of stonecutters. In very considerable part the statements concern points which Dr. Leake had elicited. The mills were inspected in company with Dr. Leake, and the men were observed while at work, talked to, and examined. A visit was also made to Bloomington, Ind., for the purpose of examining additional stonecutters.

We requested Mr. Griggs, president of the Journeymen Stonecutters' Association of North America, the local officers of the stonecutters' association, and many of the men in both Bedford and Bloomington to bring to us those who complained most, or we got their addresses and went to their homes. None of the men that we examined were sent to us through the employers, and none were examined in the presence of the employers or their representatives. In Bedford we reached them chiefly in their homes. This had the advantage of making them and their households feel quite free to talk in regard to their condition. In Bloomington, Mr. Walters, the secretary of the local branch of the stonecutters' association, brought the men to us. In both places the men seemed extremely frank and open in what they said. They are, as a class, superior men in personality, education, and manner of living. It rapidly became apparent that because the symptoms that I shall describe occur frequently, and fear had been aroused in various ways that they might grow worse, the anxiety of the men was due more to this fear of further and more serious results than to anything known to have occurred. In fact, several of those with the most pronounced manifestations said that if that was all, they thought it of comparatively slight consequence. Their fears of bad results had apparently been largely aroused within two years by their interpretation of the opinions of some physicians who had seen some affected men, but who, so far as we could learn, had not actually studied the cases or the men's work carefully, but had somewhat naturally based their advice upon the men's own apprehensions.

The symptoms seemed, from the statements of these men, as well as from statements of men who use the air hammer in other trades, to be confined almost exclusively, if not entirely, to stoneworkers, and among the stoneworkers they occur almost entirely in those who work with soft stone, such as the Indiana limestone. The reason for this becomes apparently clear when one observes accurately the manner in which these latter workmen use the air hammer, and especially the manner in which they use the stonecutting or stonecarving tools, and compares this with the details of the work of others who use the air hammer. At the same time, this offers a clear reason for the location of the symptoms and to a considerable extent at least for their character, and it furthermore suggests some very apparent expedients that may be expected to reduce the discomfort, and that if properly developed through experimentation would probably entirely or almost entirely do away with the effects which now, while apparently never serious, are easily demonstrated, uncomfortable, and justify a demand for a definite effort to overcome them.

The matter will be most evident if I first describe the symptoms and then the character of the work. As to the symptoms: We examined very carefully 19 men, and in going through the mills and upon other occasions we examined casually and talked with as many more. Dr. Leake, before and after my visit, saw many others. Nearly all of these men stated that they had then or had previously had, in very slight degree, up to a decided degree, the condition that we were there to study. This consists of temporary blanching and numbness of the fingers when the hands are chilled. It occurs almost entirely when the weather is cold or at least quite cool and when the workers are exposed to the cold—not when they are in well-heated buildings. One or two however believed that they sometimes felt it in summer, and several said that it annoyed them when "in swimming" in summer. It occurs chiefly when they start work in the morning before they get "warmed up" and lasts from a few minutes up to one and a half or two hours. A few men said it tended to recur during the day when at work. It also tends to occur when they walk or drive in cold weather, and when the hands are plunged into cold water or snow it can be brought out in a few moments. Indeed, any exposure to cold causes it to recur. In appearance and in sensation they say it is precisely like over-chilling the fingers in winter so that they "go dead," the first stage of frost bite of the fingers. As in the condition just mentioned, there may be some tingling or actual pain when it comes on and there is usually tingling when the blanching passes off, at which time it is succeeded by a flush and congestion for a little time, and at this time there may be a good deal of discomfort or actual pain which is such as most people have experienced with chilled fingers, and may extend up the arms. Occasionally this is described as severe, but usually they say "annoying" is a sufficiently descriptive term. The numbness usually does not interfere appreciably with the use of their hands. Occasionally they state that it makes them clumsy, slower and less accurate in their work while it lasts. Its distribution is striking and important in relation to its causation. In the great majority of the cases it is noticed first in the ends of the ring and little fingers of the left hand; later it is felt predominantly—in many cases solely—in the fingers of the left hand. In most instances, when definitely developed, it is felt chiefly, and is often even later confined to, an area on the ulnar side, extending back to include the two distal phalanges of the little finger or the whole finger, and running diagonally across to the index finger, where it involves only the last phalanx or a little more. It gradually increases in some cases until it involves the whole of all the fingers of the left hand, occasionally going back along the ulnar side to the wrist or over the whole hand to the wrist. The right hand is less frequently affected than the left, and then usually less markedly. When it occurs at all in the right hand, it is noticed chiefly in the thumb and index and middle fingers. In a very few cases it appears to involve the whole of both hands. The only instance of that extent that I actually saw was, however, in a man with whom questioning brought out the fact that it had not appeared, as is usual, toward the tips of the fingers and slowly increased in area, but had come suddenly over the whole area when he had "frozen" his hands during a long drive in cold weather and had subsequently, upon exposure to cold, been always of that same extent, slowly diminishing in intensity. In this case, therefore, while work with the air hammer brought out the symptoms after they had once appeared, it did not seem to have excited them in the beginning.

The distribution of the symptoms seems to be explained by the manner in which these men hold the tool in the left hand and the hammer in the right, and in the right hand a factor of importance seems to be the practice of some of the men of controlling the exhaust from the hammer by pressing the thumb, index, or sometimes the middle finger over the exhaust hole, a practice which the more skillful men say is unnecessary and undesirable.

Sometimes after prolonged work the men have flexor contraction of the fingers of the left hand for a few moments as they cease work—evidently because of the prolonged constrained grip on the tool. This is significant chiefly in suggesting the origin of their trouble.

The men sometimes complain of lameness in the arms, shoulders, or chest. Two said they slept badly and twitched and turned in their sleep after working hard with the hammer. These two, however, were in poor general condition. Various other symptoms of vague character and significance were elicited in some of the men. I may, however, for brevity's sake state here that neither questioning the men nor careful physical examination showed evidence that the symptoms mentioned or any others outside those in the hands were of any particular significance. They were rather such symptoms as some members of any group of men will always show when doing work, of whatever kind, that is at times hard work and often carried out in constrained positions. In making this last statement I exclude any consideration of the effects of dust upon the lungs. I was not asked to study that and did not do so. I would say, however, that I was not impressed with any noteworthy need of studying the dust hazard, which in working with this particular stone seems surprisingly mild.

Some excitement had been caused by the fact that one stonecutter had died insane. This case the men themselves now dismiss, however, as having been due to general paresis. One man we saw had had an ordinary acute facial paralysis. Quite naturally, in the apprehension that had been aroused, such occurrences and various vague rumors and suggestions had led to fears of "paralysis," Raynaud's disease, and a variety of other grave results. We could find absolutely nothing to justify such fears, even in the stories we were told. It is entirely conceivable that a neurotic subject might grow decidedly neurasthenic from dwelling on the disagreeable sensation that these small pneumatic hammers produce. Some of the men said that the sensation was exceedingly disagreeable to them at first, but all except the nervously over-sensitive soon get so accustomed to it that they pay no attention to it. It is in this respect like many other accompaniments of industry, as for instance the noise in many forms of work.

The symptoms in the hands, then, seem to constitute all the recognizable effects of the stonecutting and carving with the air hammer and in describing the results of physical examination and in considering the cause and nature of the condition and the possible remedies, I should be understood as referring solely to these hand symptoms.

Physical examination: When the men were at work in the mills in the early part of the day, many of them showed in mild form and extent the blanching described above. The fingernails and the affected fingers were sometimes cyanosed instead of blanched. When seen in houses or in our rooms just after they had come in from the cold the same conditions existed. It was severe cold weather during my stay there. After a short period in the warmth the affected area became flushed and then after a further period looked, and the men said felt, normal. As I said, except for occasional other symptoms that seemed to have no distinctive relation to the work, nothing else was observed and the men almost all stated that this was the whole trouble. One man showed fibrillation of the muscles of the left hand, but it was so slight as to be scarcely observable and such as is occasionally seen without definite cause and since no one else showed it, it was probably of no significance. None showed tremor except one who admitted the rather generous use of alcohol, and in him it was of the usual alcoholic character. When cold and blanched the finger movements were somewhat clumsy. When warm the motor power was normal. There was no muscle atrophy observable. The hand grip was normal, as were the wrist and elbow reflexes, in all instances. Sensation was tested to touch, to pain and to heat and cold. When blanched, the sensation to pain and to heat and cold was of course often moderately blunted over the affected area but became normal in the warmth. In two instances there was apparently very slight persistent reduction of sensation in the last phalanges of the third and fourth fingers of the left hand. Three men showed much reduced pain sense in entirely irregular and changing areas over the hands and forearms, but one of these was mildly alcoholized at the time and the other two were of distinctly neurotic character, and since the sensory disturbance was quite as marked over the forehead, face and neck on both sides, it appeared to be unrelated to the vasomotor disturbance in the hands and of no significance in relation to the actual effects of the air hammer except that a study of the hands and arms alone might easily have led to the decision that there were organic nerve changes.

It is to be noted also that most of these men, owing to the grit from the stone and the use of the tool and hammer, develop a very remarkable degree of callous on the palmar surface, and naturally this is found particularly in the areas especially likely to be involved by the phenomenon under study. The thickening of the skin frequently extends up the sides of the fingers, so as to leave soft skin on only the back surface of the fingers, approximately three-fourths the finger surface being often somewhat calloused and also much of the palm and the outer ulnar surface. Naturally, over calloused skin the sensation, especially to pain, is somewhat lessened, but this was of course equally the case in those men who had symptoms and those who had none. It is important only in showing that one might easily think, mistakenly, that there were persistent changes in sensation even when the hands were warm and normal-looking.

In the 19 examined the stereognostic sense was normal. It was examined especially because Mr. Griggs stated that the men sometimes could not distinguish coins by their feeling. In the 19 men I examined carefully the heart and blood pressure were normal in all but one, who showed a moderately high pressure. He told me, however, that he had had syphilis. In all the 19 the blood vessels felt normal, and in all, pulsation of normal characters could be felt in both radial and ulnar arteries.

Aside from the callous there was no observable persistent change in the skin. It was interesting that there was, even in the men who had had symptoms for years, none of the redness and desquamation that one sees after mild frostbite, and they had no persistent itching or burning.

The condition seems, then, to be purely a local vasomotor irritability and there seems to be no evidence of any nervous or other organic changes, except possibly, in one or two cases, extremely slight and very localized sensory peripheral nerve changes. These were, however, doubtful; they seemed insignificant at most, and may occasionally be noticed in any workingmen who bring to bear as much and as prolonged local pressure as these men do. In view of the fact that the men who get symptoms usually do so within six months to two years of the time when they begin the use of the air hammer and that a large proportion of the men we examined, as well as very many others, have used the air hammer for many years, and nevertheless no worse results could be discovered, it is wholly reasonable to conclude that this comprises the sum of the results and no organic changes or more disturbing functional changes are likely to occur.[1]

We were unable to see or to learn of any cases in which the condition described actually interfered with the men's occupation as stoneworkers, though we were told of two or three cases in which they gave up this work, either because of the discomfort it caused in cold weather or because of apprehension that it might grow worse. There does seem some possibility of its being a distinct disadvantage if the man wishes to go into certain other forms of work that cause exposure to cold. One man told me he had originally been a car builder, and after using the air hammer in stonework he tried to go back to his old trade because he had had difficulties with the foreman in the stone mill, but had to give it up because he could not hold a cold chisel firmly with his numb fingers in cold weather.

We were told of several young stonecutters who had been drafted into the National Army and who were said to be having a very uncomfortable time in the cold weather, especially in carrying a rifle. Gloves do not suffice to prevent the effect of very cold weather.

However, skilled stonecutters usually stick to their trade and, as stated, I found none whose stonework was either prevented or seriously interfered with. One man of those seen had given up working on limestone and was using the hammer with comfort in working on granite, perhaps because both tool and hammer are used differently on granite. Five men stated that they had earlier had the trouble decidedly, but that it had gradually lessened until it had almost entirely disappeared. They attribute this to having learned to use the tool with greater skill and especially with an easier and less cramped grip. Other experienced workmen told me the older and more skillful men have less bother than the younger and less skilled and attributed this to the same cause and to the fact that the young men use the mallet little in "roughing out," while the older have more familiarity with the mallet and use it a good deal. Mr. Griggs stated also that it is more common in the young men than in the older. He believed this due to the more common use recently of the larger hammer, but the older men state that they use the larger hammers as much as do the younger.

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[1] It is of some interest to note that one, and I think also a second, man said that when seen a few days before by Dr. Leake he had tried to bring out the phenomenon by plunging his hands into snow, but was surprised to find it would not appear, though usually marked. He said that he remembered afterward that he "had had a couple of drinks of whisky just before." This is of interest and some importance in that it indicates both the mild character of the disturbance and its apparently purely vasomotor origin, since it was entirely overcome by the mild vasodilator action of the moderate amount of alcohol.

In considering the cause, the precise character of the work must be appreciated. It is easy to see, when one tries personally some of the various uses of the pneumatic hammer, why peculiar results may occur with soft-stone workers. In the first place they use hammers of very rapid action. We were unable to get a reliable and definite statement as to the number of blows delivered by these and other air hammers. Dr. Leake is endeavoring to determine the number accurately. It is said to be, with the smaller of these hammers, approximately 3,000 to 3,500 a minute, with the larger, 2,000 to 3,000. Whatever the exact figures, the blows are so frequent that they can not be appreciated individually by the ear, but make a continuous note, whereas the hammers used in riveting and most other metal work act much more slowly and the individual blows can be heard. The vibrations are therefore much finer and more frequent in the hammers used by the stonecutters. The difference one appreciates at once when holding the hammers at work.

Probably much more important in explaining the special occurrence of these symptoms in the soft-stone workers is the manner in which they hold the hammer, and more especially the fact that they work with a tool held by the left hand in a peculiar manner. The riveter simply grasps his larger hammer with both hands in a manner convenient to reach the rivet with it. There is no loose tool to be held. The granite worker holds the hammer perpendicularly grasped in his right hand, and while he does use a tool in the left hand it does not need to be gripped firmly or guided forcibly except in doing lettering or other fine work. These workers in limestone, however, hold the hammer in the right hand as one uses a pen, whatever force is exerted upon it being exercised by the thumb, fore, and middle fingers; the tool, like the hammer, is held obliquely, but of course in the left hand, is gripped firmly, held closely against the stone, and guided, by a pressure exerted especially by the last two fingers and running along a line which is practically that which I described as delimiting the extent, toward the hand, of the vasomotor phenomenon as usually seen in the left hand. The use of the left hand in calking and chipping seems superficially to be much the same, but when one tries it, it is at once apparent that in these operations the tool needs relatively little guiding or pressure, and for this reason and because the tool is larger (the shank of the stonecutting tool is only half an inch or often less), the grip of the left hand is very much less forceful and constrained than the soft-stone workers.

It will, I think, be apparent that the symptoms in the latter correspond in area closely to those areas of the fingers that are forcefully used and extend from there peripherally. It is to be remembered that these men use their hands continually for most of their working days in this manner, unless they get frequent change by using the mallet. But most of them nowadays use the mallet little. It is interesting that some of the men state that they had the same symptoms when working in earlier years with the mallet, but apparently this was unusual and the symptoms then ordinarily were, they said, slight.

There are three chief factors that evidently may play a part in producing the symptoms: Cold, constriction, and vibration. Cold is evidently the chief factor that temporarily excites the symptoms, as few of the men have any trouble except in the cold. But in the many other trades in which the hands are equally exposed to cold this phenomenon appears to be unusual. In fact, the stonecutters were, in earlier years, when they used the mallet, more exposed to cold than now. I am inclined to believe that cold elicits the symptoms rather than produces them, but it nevertheless gives the men discomfort. The factors more peculiar to this trade are the constriction of the grip exercised and the vibration. The vibration occurs almost equally, if not equally, in other work in which the air hammer is used, with relatively little or no such effect; also, if the vibration were the chief cause, the affection would be expected to occur more diffusely over the hands (since the whole hand feels the vibration), and in more irregular distribution, and particularly it would be expected to spread radially from the source of vibration, instead of being, as it is, observed peripherally only, in most cases, and usually first in the finger tips. It seems probable that the most important factor and hence the one to be especially obviated is the continuous constriction. Much the same phenomenon may be temporarily brought out easily in most persons in cold weather by a similarly strained continued grip. It can not, however, be either denied or affirmed with the evidence at hand that the vibration is a factor of importance.

It is obvious that certain simple things may be done to attempt to eliminate the trouble. First of all, the shank of the tool, where it is held, could be made larger, so that the grip need not be so strained. In doing this it would be well to use some substance that would conduct cold or heat poorly, instead of, as at present, intensifying the effect of cold by holding the cold metal. Asbestos suggests itself, and its practicability could be tried. Some of the men have tried rubber hose drawn over the tool, but said it tended to work upward on the tool and choke the action of the hammer. One man, however, said that he soaked the hose in oil, drew it on his tools, and allowed the softened rubber to adhere to the tool in drying and thereby was able to use it successfully. He said that he had earlier had "dead fingers" but is no longer troubled by them. Asbestos, if practical, would have evident advantages. Some such handle would perhaps serve also to some extent as a shock absorber and thus reduce the possible effects of the vibration. It is possible, too, that practicable methods of keeping the tools warm in cold weather could be easily devised and would reduce the discomfort. It is also to be noted that the practice of controlling the exhaust with the thumb or fingers of the right hand should be discontinued. In the same connection it is to be observed that in some hammers, due either to their construction or to wear, the exhaust leaks out downward along the tool—which it should not do—giving a slight constant blast of cold air on the left hand. This should be obviated. Heating the compressed air has, I believe, been tried, but meets with difficulties, and I do not believe it would be of much value if successfully done.

Reducing the time spent at any disadvantageous work and shifting to other forms of work is in many kinds of industrial disorders sufficient largely to overcome the trouble. In this instance there is an obvious way of accomplishing this—by requiring the men to use the mallet in suitable parts of the work, especially in "roughing out." The operators say they have always preferred that this should be done, especially because compressed air is expensive, but that the men will not do it. The men admit they use the hammer in such work when they do not need to, partly because they get more done, but they say that unless they do the foremen look unfavorably upon them and are likely to drop them because they do not work so fast. Evident adjustments and understandings are needed on both sides here. Both the men and the operators and their foremen should recognize that the frequent shift to the mallet may go far to obviate the trouble. While the tool is held in much the same way when employing the mallet, there is a slight, almost automatic, relaxation of the grip on both the tool and the mallet handle after each blow, and this alternating relaxation and contraction is just the desirable offset to the constant constriction exercised when using the air hammer.

Mr. Griggs stated that he believed the 1-inch hammer should be done away with in this work and only the ¾-inch hammer used. The men differ very much on this point. Many think the smaller hammer gives them more discomfort. Certainly the immediate sensation one gets in using it is more disagreeable than with the larger hammer, owing to the more frequent and finer vibrations. I do not believe that with the evidence at hand it is possible to say whether limiting them to the smaller hammer would help directly, but it would perhaps lead the men to use the air hammer less in "roughing out," and if that were the case it would probably indirectly do good.

Besides these obvious measures, there is little doubt that having in mind the above-mentioned factors that are probably active in producing the trouble, an ingenious person of mechanical training and familar with the practical needs in the work could by some study and experiment devise changes in the tools or the hammer, or other changes, that would improve upon the above suggestions; and if the latter were not of the character needed, he could devise means that would be successful. While the disorder is not, under present conditions, such as to justify any fear of more serious results, it is uncomfortable and possibly of some economic disadvantage to the men, and it is due to them that such studies as the above be made by the manufacturers of the hammer, or more especially by the soft-stone operators, since of those who use the pneumatic hammer it is their interests that are particularly involved.

PHYSICAL FATIGUE AS A FACTOR IN INCREASING SUSCEPTIBILITY TO COMMUNICABLE DISEASE.

Fatigue in its relation to health has been the subject of many investigations. With the beginning of the present world war and the immediate need for soldiers, sailors, and munitions, the question became one of great importance. The effects of fatigue in the making of soldiers, sailors, and munitions should be very carefully watched with a view to maintaining the output of training camps and munition factories at its highest level during the war. No necessary sacrifice of men should be questioned at this time, but when methods employed for speeding up this output are liable to "invite disaster," such methods should be carefully revised.

In the investigations made into the prevalence of communicable diseases by the Division of Sanitation, Bureau of Medicine and Surgery, Navy Department, the conclusion was reached that fatigue was a factor in their spread, and that "the attempt to make a sailor too rapidly is to invite disaster."